Memo

To: File

From: Neal Farmer, Idaho Department of Water Resources, Planning Bureau

Date: September 25, 2008

Re: Rangen Monitor Well Drilling

A geologic exploration test hole was drilled and completed as a monitor well east of Rangen, Inc. on August 5, 2008 (Figure 1). The short term goal was to allow for collecting rock samples to provide for a better understanding of the subsurface geology and then use the well to collect water levels for long-term hydrologic data.

Drilling Procedure

Eaton Drilling Co. (Dave and Tony were the drillers) used an air rotary rig (with no top head hammer attached) to drill a nominal 8-inch diameter hole from ground surface down to approximately 63 feet. There were little or no returns, a loss of circulation, and groundwater was not observed in the basalt. Six inch diameter steel casing was then installed from + 2 feet above land surface down to 62 feet below land surface. A nominal 6-inch diameter open borehole was drilled to 165 feet below land surface using foam and water in the compressed air for circulation. After the driller tripped out of the hole from a depth of 165 feet, it collapsed up to 80.6 feet below the top of the casing (T.O.C.). Pea sized gravel was poured into the annular space and then seven 50 pound bags of granular bentonite was poured up to land surface and the casing perforated with an air perforator from 63 feet up to about 53 feet depth. The well was capped with a locking cap and secured with a padlock.

General Geologic Description

Figure 2 shows the geologic log, most recent water level and well construction for the monitor well. The well was drilled to 165 feet but the sediments collapsed up to about 80 feet below T.O.C. Generally, there was 8 feet of soil then basalt was encountered from 8 feet down to about 68 feet (+/- 2 feet) below land surface. The basalt exhibited numerous fractures, rubble zones with cinders and voids. The color is a typical dark grey and contains feldspar laths, vesicles, and some glassy surfaces that indicate fast cooling conditions.

South of Rangen by about one mile is an outcrop showing the Quaternary basalt contact with underlying sediments on the eastside of the Hagerman Valley (Figure 7). Clearly shown in outcrop are subaerial clastic sediments of a paleosol directly under a pillow lava rubble zone and the overlying massive portion of the basalt flow which is cliff forming. The contact shows the effects of loading saturated sediment which produces load cast features. It is interpreted that the paleosol was very soft from a wet environment before the lava flow occurred and/or became saturated from flood waters damned by the lava flow prior to loading of the sediments by the ensuing lava flow.

Clastic sediments were encountered from 68 to 165 feet and range in composition from clay, silt, sand and gravel. The geology shown in Figure 2 is consistent with previous conceptual models based on outcrop and adjacent wells (Figure 6). Samples collected are consistent with known outcrops of two formations of Tertiary age sediments in the Hagerman Valley area known as the Glenns Ferry Formation (GFF) and the Tuana Gravel Formation (TGF) (Figure 8). Initial observations of the physical character indicate these sediments are from both the GFF and the TGF. However, the upper sand and gravel could be Quaternary in age and may have been deposited on top of Tertiary age sediments of the GFF. The sediments indicate a fluvial depositional environment and the outcrop of pillow basalt lava at the Curren Tunnel (Figure 4) is consistent with this environment and depositional setting. The tunnel is constructed into a pillow basalt rubble zone of high conductivity. It is likely located within a 'thalweg' part of an ancient topographic depression, valley or ravine cut into the GFF where there could have been a stream or small river flowing when the basalt flow entered the depression which produced the pillow basalts when it encountered water.

The character of the basalt encountered during drilling of the well, indicates that it has numerous rubble zones, cinders, and voids for most of the thickness and the driller had to case this section to hold back the cinders and maintain circulation. A nearby well log report for "Harvey Tate" dated April 14, 1992, also shows a significant thickness of "black cinders" from 26 to 66 foot depth (Figures 5, 5a and 6). This type of geology is typical of high conductivity zones elsewhere in the Eastern Snake River Plain for example at 'Ten Springs' and the Thousand Springs Complex located 2.5 miles south.

A small canal or large ditch is located nearby (Figure 1) and during a discussion with Lonnie Tate he noted that it isn't used much any more since the conversion from furrow/flood irrigation to sprinkler technology. I recommend this site be explored as a possible small scale or 'pilot' aquifer recharge site and it would most likely benefit the Rangen Spring complex area. The geology at this site is more permeable and therefore more conducive to receiving injected recharge water than my observations of the "W-Canal Aquifer Recharge Site" geology and slug tests performed at this site. It is reasonable to conclude based on the local geology; if an aquifer recharge pilot test was employed near Rangen the local groundwater and springs would have a discernable and measurable response if the conveyance system has enough capacity.

Fluorescent dye tracer tests should be performed before exploration of the site by injecting either Fluorescein or Rhodamine into the monitor well and then monitor the springs to determine the location of dye discharge, time of first arrival and total time-of-travel. Both dyes are certified by ANSI/NSF for Standard 60 potable water supplies and approved by the EPA for public drinking water supply systems. They can be detected in extremely low concentrations of 1 part per billion which is well below the visual concentration. IDWR staff currently has the dye, equipment and expertise to implement the tracer test at a very low cost. The dye test would also help with interpreting and correlating the long-term water monitoring data sets with the spring flows as well as making a quantified determination of some aquifer parameters. I recommend a minimum of two additional exploratory boreholes to be drilled near this site locating them north and south of the current monitor well by about 200 feet. It would also be useful to survey the exact location, length and orientation of the Curren Tunnel in the subsurface prior to drilling. Also, an additional geologic exploration borehole is recommended east of the Hagerman Water Users spring complex by 350 feet and north of Big Springs by 1,400 feet (T7S R14E, section 18, SW of the NW) to confirm the Quaternary and Tertiary (Q/T) contact at this location.

The water level in the monitor well is about 10 feet higher than the elevation of the water surface of the spring discharging from the end of the Curren Tunnel. Water levels in the well are shown in Figure 3 and Table 1. The spring water elevation where it discharges from the Curren Tunnel is 3,145 feet. The elevation of the water level in the monitor well is 3,155 feet. According to Rangen staff Lonnie Tate, Rangen obtains about 2/3 of its water from spring zones below the Curren Tunnel with a large discharge area just south of the Curren Tunnel 100 to 200 feet that will be noted as the 'lower spring zone'. The remaining 1/3 of their water comes directly out of the Curren Tunnel. The approximate elevation of the lower spring zone obtained with a GPS is 3,100 feet and a few pieces of subrounded stream gravels of Rhyolite composition (typical of the Tuana Gravel Fm.) were observed as float within the lower spring zone. The lower spring zone and float gravel correlate with gravel encountered during drilling of the monitor well at an elevation between approximately 3,100 and 3,125 feet (Figure 2) and this stratum may represent a higher conductivity aquifer flow zone that the lower spring zone is flowing through.

There is an apparent downward hydraulic gradient within the GFF as illustrated in the wells "Rangen M.W.", "Hosman" and "Waters" that show water levels dropping as the wells are completed to deeper depths (Figure 6). But, the Ramsey and Anderson wells might have an upward hydraulic gradient from the underlying deep basalt aquifer located beneath the GFF. Better evidence of this upward hydraulic gradient is recorded from a USGS monitor well located due east of Rangen by 2.9 miles (T7S R14E, section 35, SW SW). The well was screened within the deep basalt aquifer from an elevation of 2,720 up to 2,840 feet and then sealed with a static water level of 85 feet (3,200 feet elevation) below land surface which indicates a confined aquifer with an upward hydraulic gradient. There are sediments noted in the log between 2,840 and 3,030 feet elevation and it is reasonable to conclude these sediments are an eastward extension of the Glenns Ferry Formation.

Another well that is completed to a depth of 1,013 feet is located west by northwest of Rangen by 3.8 miles in T7S R13E, section 27, NW of the NE. It is artesian with a well head elevation of 2,900 feet or about 100 feet above the level of the Lower Salmon Falls Reservoir (elevation 2,800 feet); and 24 feet higher than the Snake River (2,876 feet) at Sligers Hot Springs. The last name for this well is "Smith" and the water temperature is about 70 degrees Fahrenheit at the well head indicating an aquifer that is not dominated by colder river water or spring water. Discussion of these and other distant wells is somewhat out of scope for the purposes of this memo but should be noted briefly. A recent geologic exploration borehole was drilled at the University of Idaho Fish Aquaculture Research Station located at T8S R14E, section 6, SE ¼ on August 20, 2008. Borehole geophysics was performed and the report is in progress but the preliminary temperature log shows a shift from about 61 degrees Fahrenheit from 220 feet and then a sharp increase to 66 degrees from 220 down to 240 feet with a temperature high of 68 degrees at a depth of 350 feet. The hole collapsed below this depth. These temperatures indicate an aquifer that is not dominated by upper elevation springs or river water and may be from the deep basalt aquifer system noted in the previously discussed wells. Based on an evaluation from the wells noted in this document as well as over 100 other wells in the area and geologic outcrops, it appears there are numerous groundwater flow paths and possibly a separate deep aquifer system but more information is needed to confirm this. Figure 11 shows a conceptual block model of the east and west side of the Hagerman Valley. The GFF is well exposed on the west side but mostly covered on the east side by talus, landslides, and vegetation. A detailed discussion about the greater hydrogeologic context for the area from Bliss, to Wendell to Thousand Springs and the Hagerman Valley is in progress and forthcoming.

Coordinates and elevations were obtained using a Trimble GeoXT 2005 model GPS and occupying a point for a period to collect 100 readings which were post-processed in the office. The maximum PDOP value of 4 was selected to obtain the best accuracy this model is capable of. Quality control and assurance included using the same method and collection on a known US Geological Survey bench mark in the Hagerman Valley. The bench mark has known coordinates from professional grade surveys and they were compared against the GPS coordinates to obtain a level of accuracy.

On the day of surveying the Rangen Monitor Well the accuracy of the GPS, when evaluated against the bench mark was:

easting = 0.5 feet.

northing = 8.4 feet.

elevation = 0.9 feet

On the day of surveying the Rangen Spring discharge the accuracy was:

easting = 4.3 feet.

northing = 5.7 feet.

elevation = 3.6 feet.

The individual days of GPS data are consistent with the total running average accuracy for this same GPS unit during the past year which is:

easting = 3.4 feet

northing = 5.4 feet

elevation = 3.5 feet

Figure 1. Location of Rangen monitor well 588 feet due east of Curren Tunnel and a nearby canal.

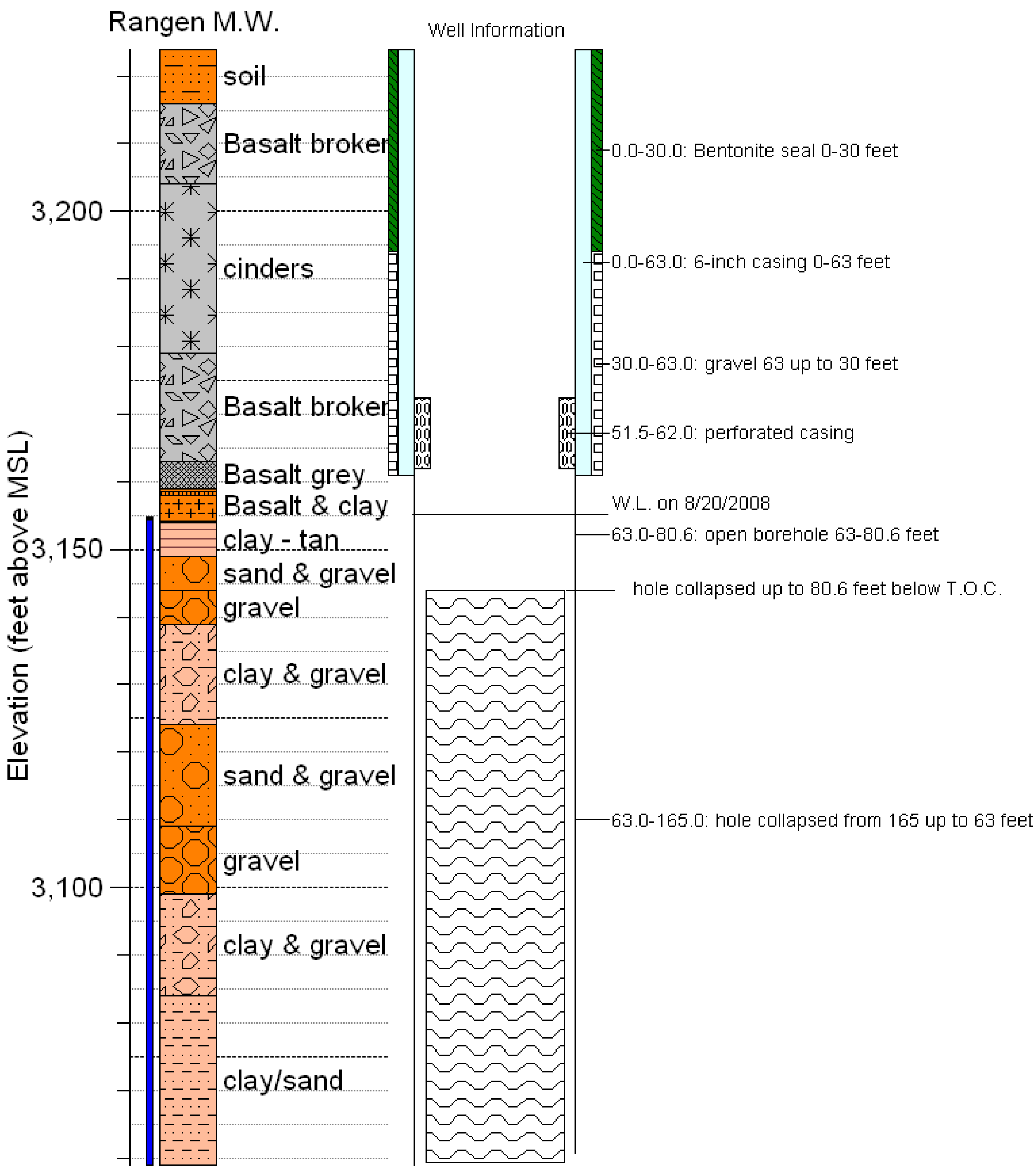

Figure 2. Geologic column and well construction for Rangen monitor well.

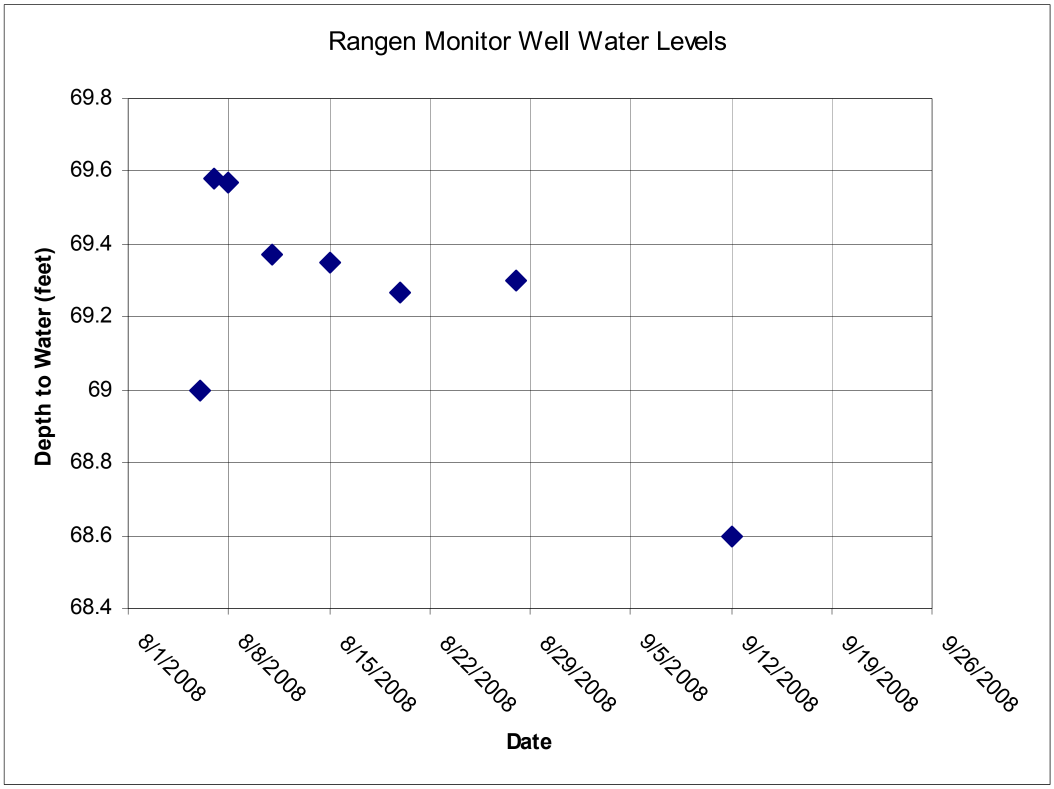

Figure 3. Updated static water levels at time of printing for Rangen monitor well.

Date	**Depth to Water** in feet below top of casing (* = well sounding depth)
*8/6/2008	* 80
8/6/2008	69
8/7/2008	69.58
8/8/2008	69.57
8/11/2008	69.37
8/15/2008	69.35
*8/20/2008	*80.6
8/20/2008	69.27
8/28/2008	69.3
9/12/2008	68.6

Table 1. Static water levels from the Rangen monitor well measured from the top of casing.

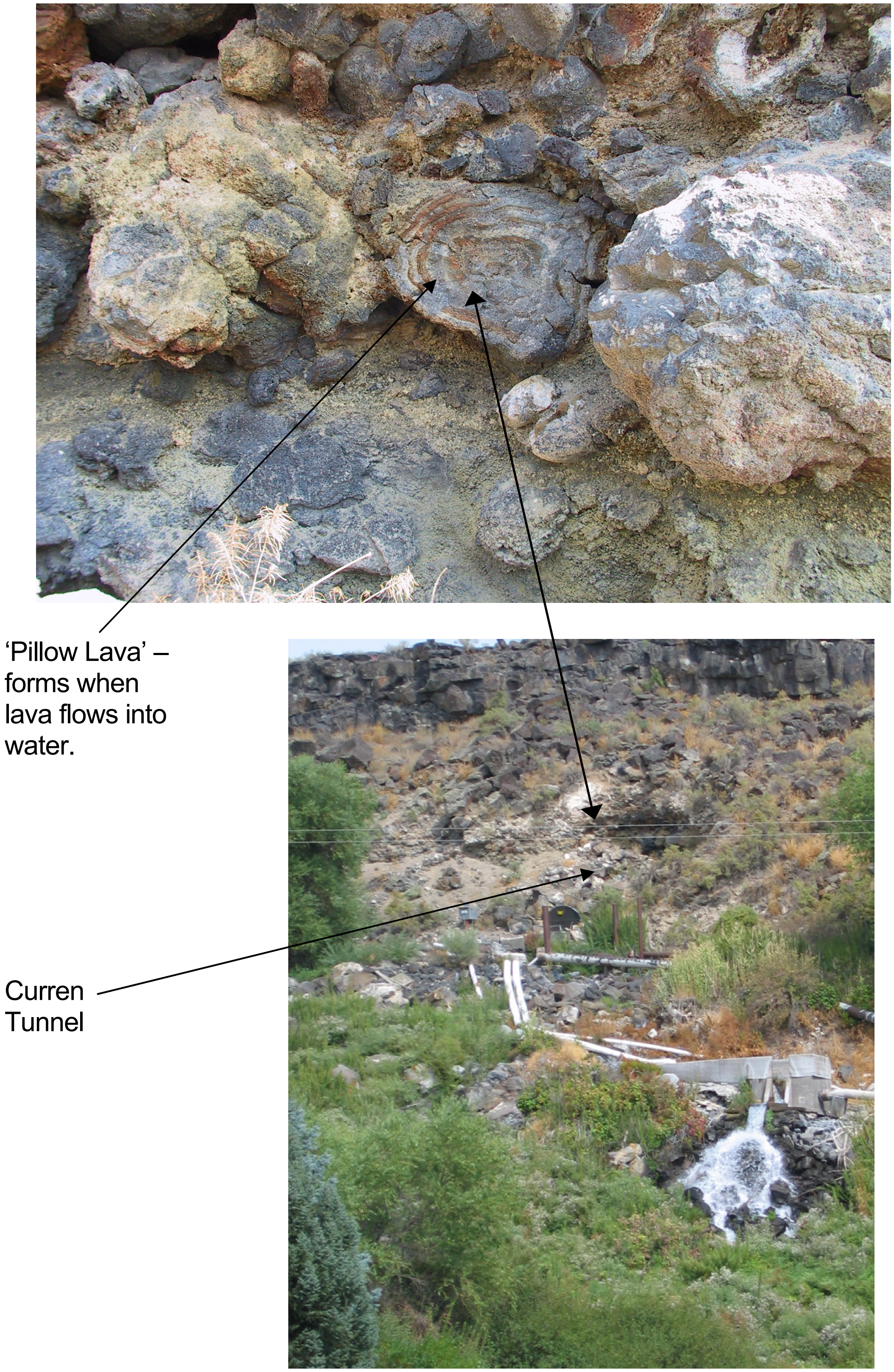

Figure 4. Curren Tunnel and pillow basalt of about 1 foot diameter.

Figure 5. Locations of nearby wells and a geologic outcrop southeast of Rangen by one mile at a dairy previously owned by Butch Veenstra.

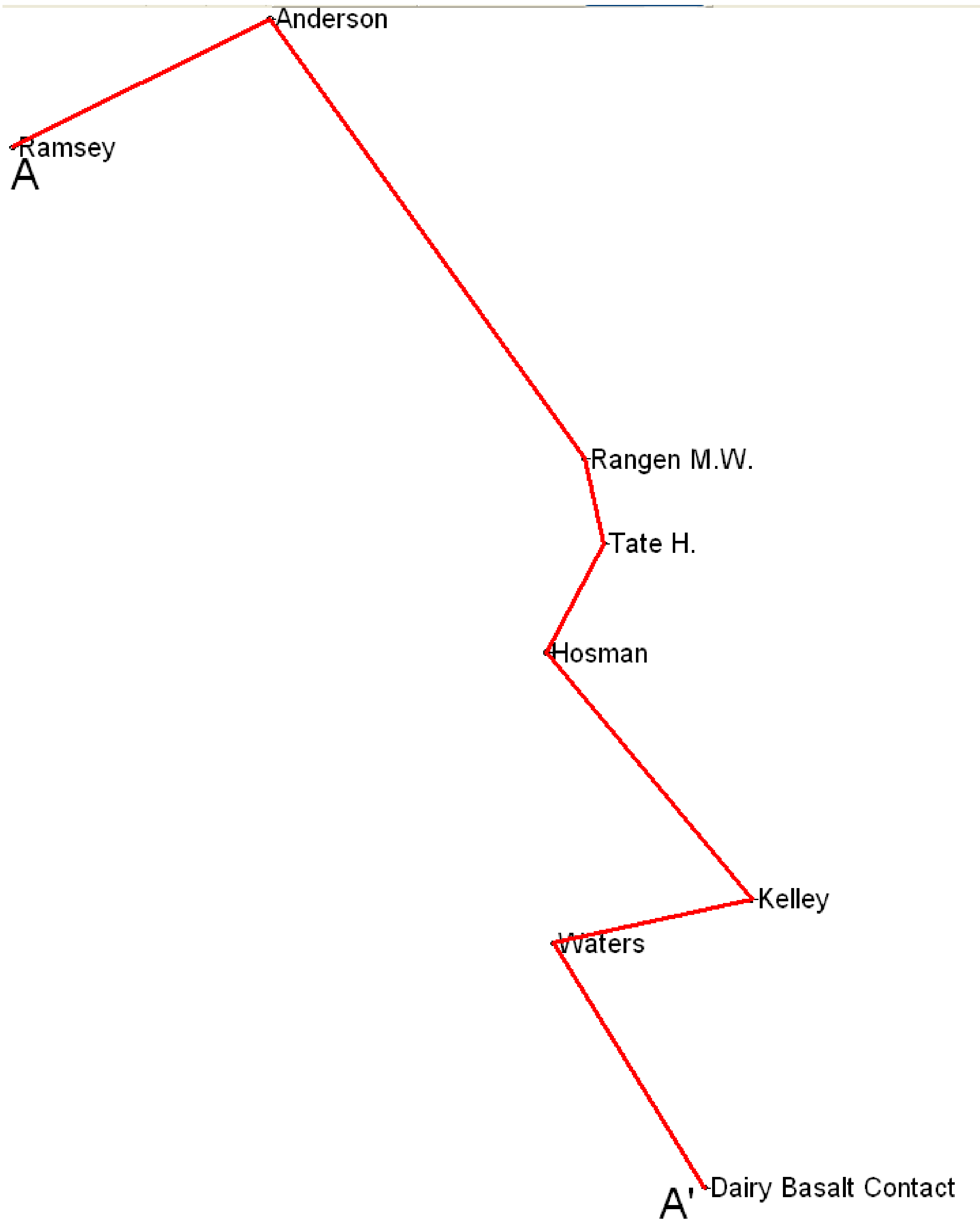

Figure 5a. Geologic cross section A (north) to A' (south) location map.

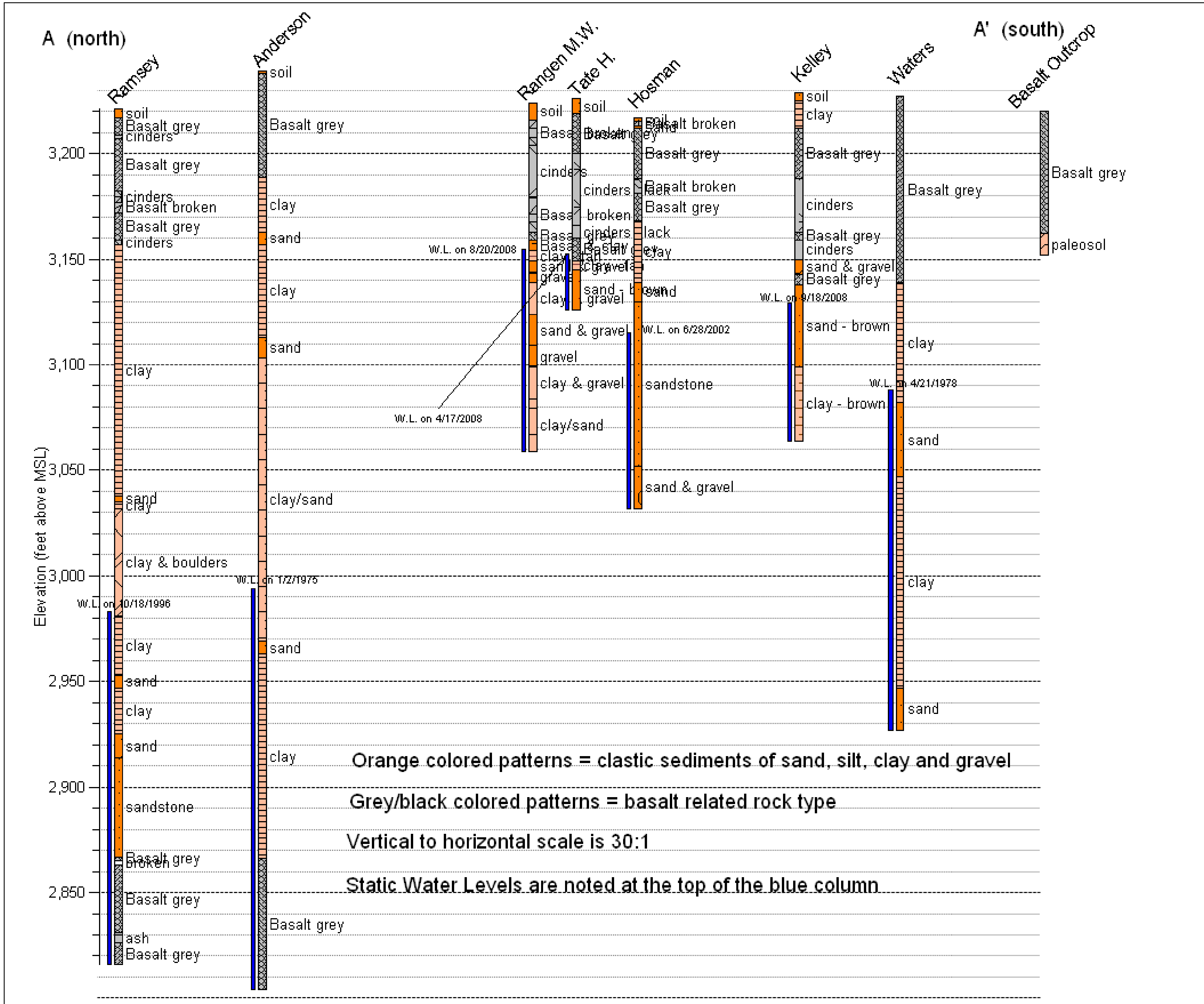

Figure 6. Geologic cross section for nearby wells shown in figures 5 and 5a and a basalt outcrop.

Name of Well Owner	Township Range Section	IDTM Easting (meters)	IDTM Northing (meters)	Well Depth (feet)	Depth to Water (feet)	GPS Elevation on T.O.C. (feet above MSL)
Doug Ramsey	T7sR14e 31	2429621	1287270	405	238	3221
Warren Anderson	T7sR14e 30	2430178	1287549	435	245	3239
Harvey Tate	T7sR14e 32	2430901	1286409	100	73.6	3226
Chris Hosman	T7sR14e 32	2430776	1286172	185	102	3217
David Kelley	T8sR14e 5	2431220	1285636	165	100	3229
Craig Waters	T8sR14e 5	2430791	1285541	300	139	3227
Rangen MW	T7sR14e 32	2430858	1286592	165	69.27	3237
Basalt outcrop	T8sR14e 5	2431116	1285014	n.a.	n.a.	n.a.

Table 2. List of general information for wells used in cross section.

Figure 7. A massive cliff forming basalt overlying a pillow rubble zone which rests unconformably on a paleosol outcrop south of Rangen by one mile. The elevation of the paleosol and pillow zone is 3,162 feet above MSL.

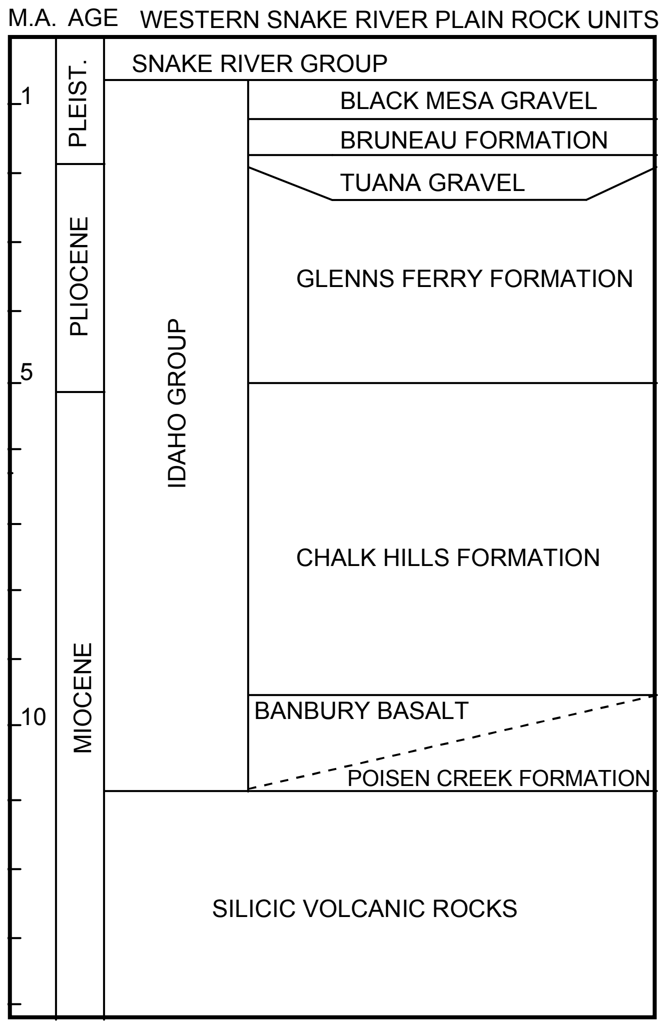

Figure 8. Sequence of upper Cenozoic rocks in the western Snake River Plain, Owyhee County, Idaho (modified from Malde, 1991)

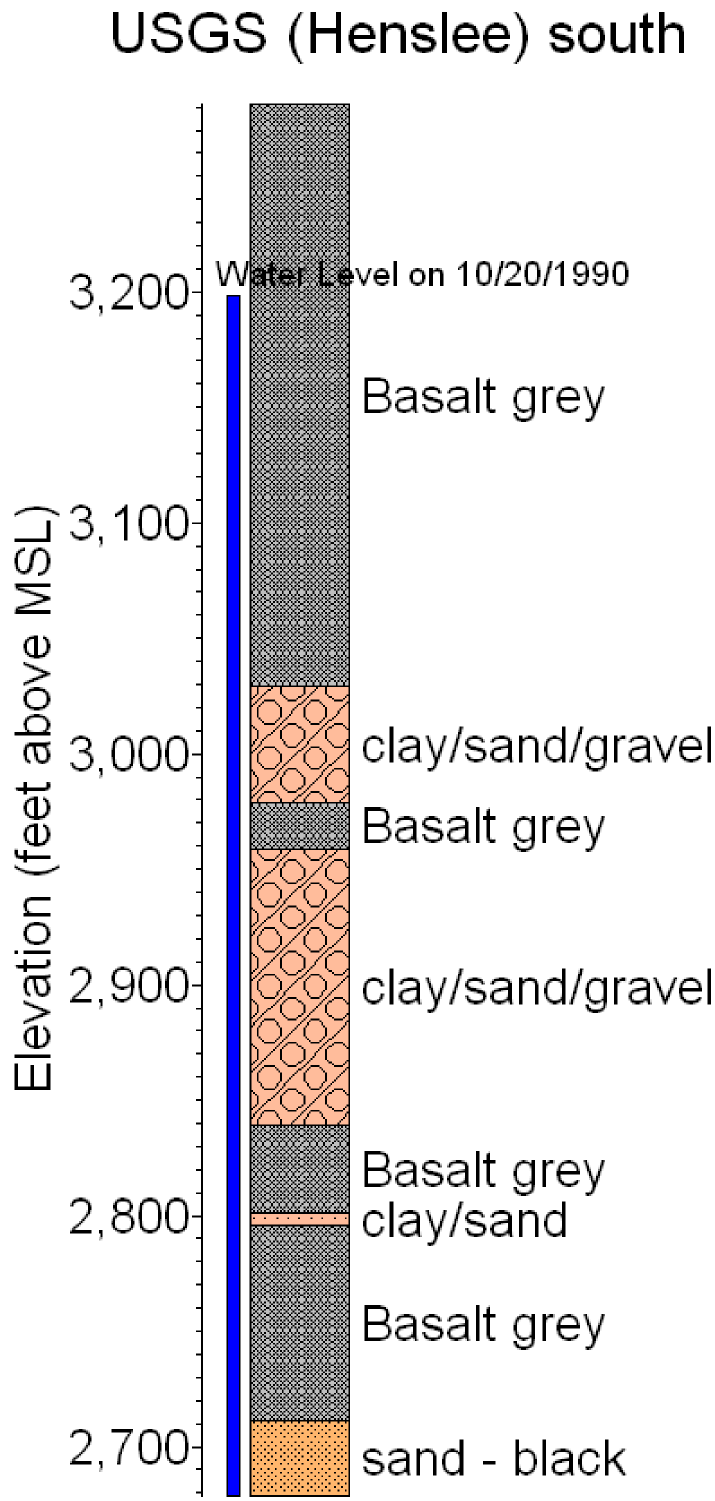

Figure 9. U.S. Geological Survey monitor well located at T7S R14E, section 35, SW SW east of Rangen Spring by 2.9 miles. The log is consistent with geologic outcrops in the Hagerman Valley and two other wells “Ramsey” and “Anderson” at T7S R14E, section 30.

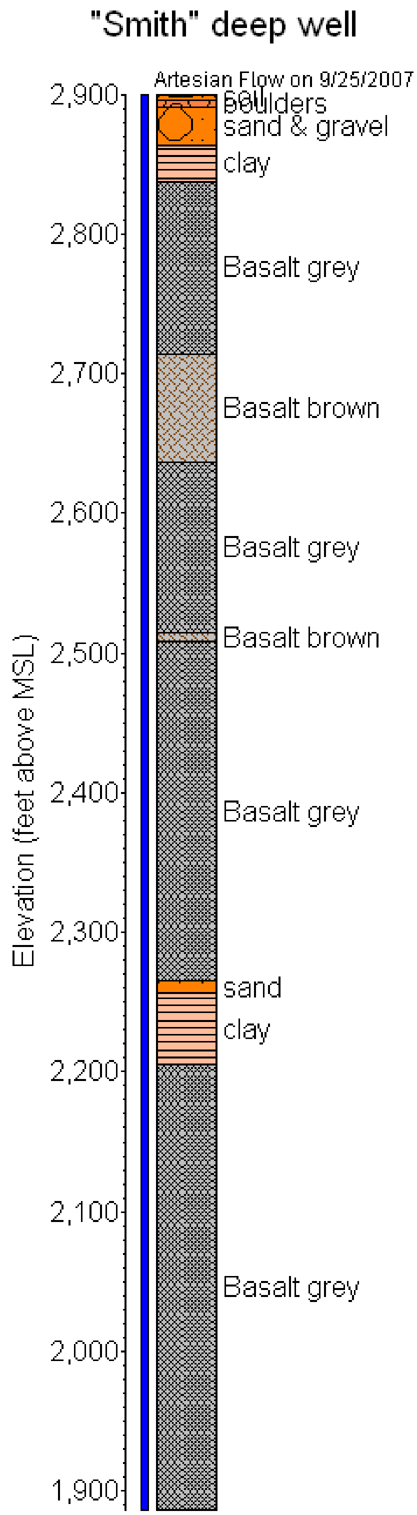

Figure 10. "Smith" deep well located in the Hagerman Valley at T7S R13E, section 27, NW of the NE. The well is artesian with a surface water temperature of about 70 degrees Fahrenheit.

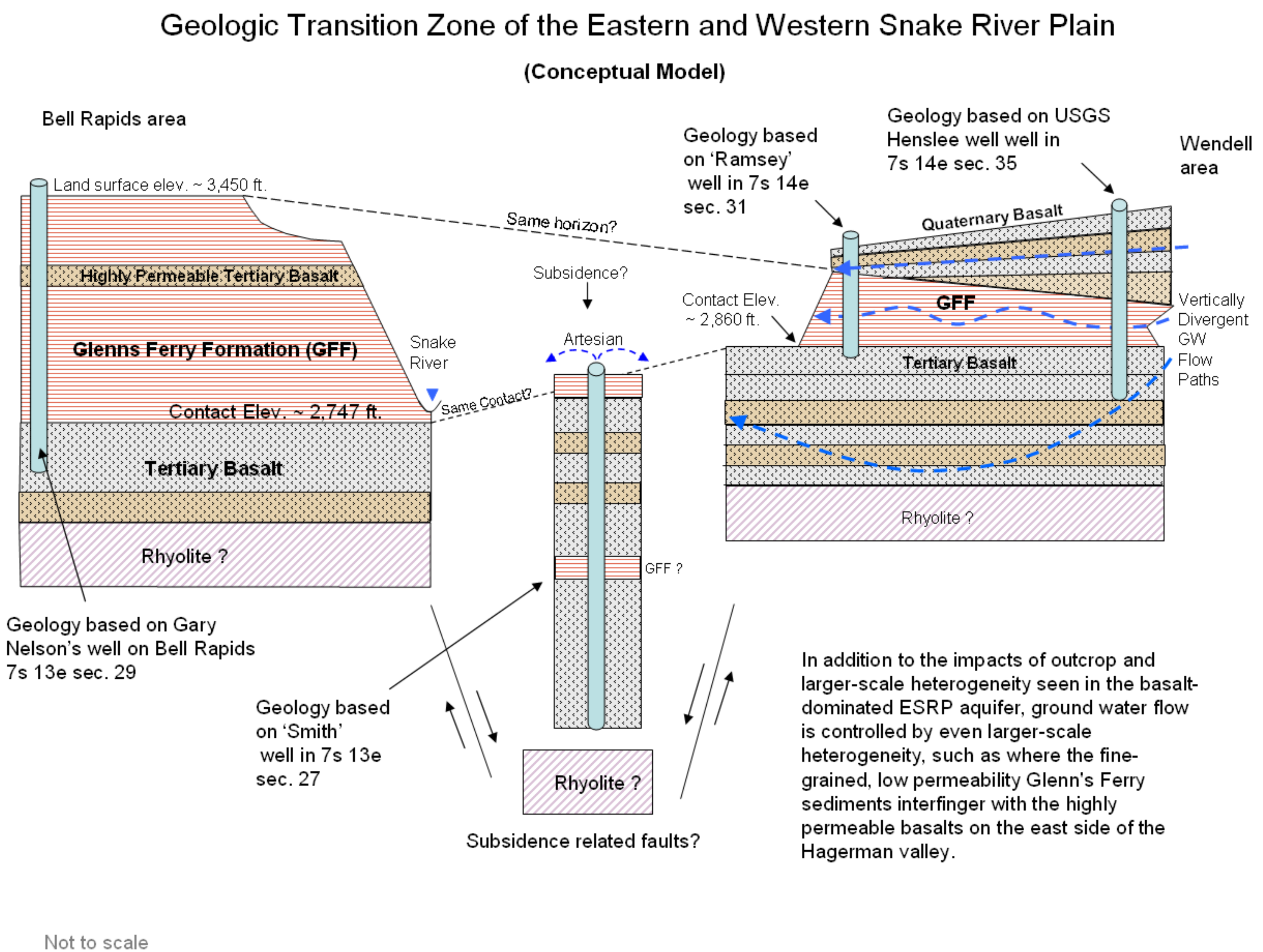

Figure 11. General conceptual block diagram of the Hagerman Valley geology showing the GFF 'wedging' into the ESPA toward and thinning to the east toward the city of Wendell.